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A Critique of the EPWP Infrastructure Sector – Part 1

This is the first of a series of articles which explain the context and framework of modern labour-intensive construction in South African public works programmes, leading to a critique of the Infrastructure Sector of the Expanded Public Works Programme (EPWP) 2004/05 to 2013/14.

SYNOPSIS

The Expanded Public Works Programme (EPWP) is a component of the South African government's response to the triple challenge of poverty, unemployment and inequality. Work provides an income and contributes to personal dignity. The Infrastructure Sector comprises nearly 80% of expenditure on the EPWP.

Conceptualisation of the EPWP was partly based on large-scale, long-term programmes established elsewhere in sub-Saharan Africa during the 1970s to 1990s. The use of *modern labour-intensive* methods lay at the core of those programmes.

On conventional capital-intensive construction, labour-intensity is usually far below 10% of site-construction expenditure. By contrast, *engineers re-engineered product and process* to obtain a 30% to 65% site expenditure on productive employment, without compromising time, cost and quality (once systems were established). The range of labour-intensity varied according to the category of construction. In other words, by comparison with conventional construction, the use of modern labour-intensive methods increased the employment generated by 300% to 650%. This was not achieved by superficial tinkering.

Following the re-engineering of product and process an alternative socio-technical system of construction was established – *programmes* of construction and maintenance were established with direct links to training, in particular 'hands-on' single- and multi-site supervisors.

In a few countries in sub-Saharan Africa, including Kenya, Botswana and Lesotho, modern labour-intensive methods of construction have been promoted on a large scale over the long term in order to generate skills and employment during the provision of public infrastructure. This has been achieved without compromising time, cost and quality. Thousands of skilled 'hands-on' single- and multi-site supervisors have been trained, hundreds of thousands of years of employment have been generated and thousands of kilometres of rural roads have been constructed and

maintained. For every kilometre constructed, permanent employment on maintenance was generated.

During the first two phases of the EPWP (2004/05 to 2013/14) the Infrastructure Sector of the EPWP failed to achieve the levels of labour-intensity anticipated in its formulation. The extent of the failure may be judged by the following: labour-intensity has remained stubbornly around 10%, which is barely more than could be achieved using conventional methods.

This series of articles analyses the reasons for this failure. In order to do so, one first has to provide a framework for assessment based upon the theory, principles, research and large-scale practice over the long term, of 'modern labour-intensive construction'. Furthermore, in South Africa it has been demonstrated that modern labour-intensive methods may be used for high-standard infrastructure.

Having provided a context for a *constructive* critique, one will then call particular attention to the ways in which the implementation of the EPWP *departed* from the successful model that was based upon large-scale implementation over the long-term.

In contrast to sub-Saharan *programmes*, it did not establish a *programme* of construction of related projects. It did not set up *formally linked* training programmes to produce large numbers of 'hands-on' single- and multi-site supervisors. In particular it *did not even establish the Training College to which it was committed in its own original Consolidated Programme Overview and Logical Framework* (June 2004). Furthermore it did not establish an 'in-house' implementation capacity at local, provincial or national level. Consequently the public sector did not develop an 'in-house' capacity to evaluate implementation.

Particular attention will be called to the EPWP's decision to rely upon independent small contractors and therefore the reliance upon the contract, while largely ignoring the lack of experience or training amongst the target group.

Engineers have a clear role with respect to the physical components of high-quality public infrastructure.

Public funding is being used for the construction and maintenance of public infrastructure. It is reasonable that government should set criteria for the use of public funding. Engineers could play a much greater role in relation to 'secondary' socio-economic benefits of public expenditure, in particular skills development and employment creation. *Warning:* Although there would be a humanitarian component to such an approach, technically sound considerations must be pre-eminent. If the social welfare component is too dominant, engineering considerations are relegated and very little of physical value will be built.

Articulation of an alternative, economically efficient product is complicated by the fact that the existing 'socio-technical system' of the construction industry is based upon the use of fuel-powered, heavy equipment. In the face of this, engineers have to perform extensive *re-engineering* of product and process in order to achieve a technically sound product and socio-economic objectives. The time, effort and commitment required to execute this task must not be underestimated. Such being the case, it is simpler to introduce radically different techniques through *instruction* rather than *contract*. Here, this injunction applies directly to skills development and employment creation. It would also apply to any other of the current 'buzz words' such as *community participation, small contractor development, sustainability, green building, women's empowerment* and the *upskilling of youth*. These terms are so easy to add to the list of objectives, but it is very difficult to actually make a significant difference.

INTRODUCTION

Dire situation in South Africa

In South Africa there are insistent demands for public infrastructure and housing. These demands for public services lie at the core of current community discontent.

Communities are also demanding 'jobs'.

Levels of unemployment are extremely high and disturbing. The 'narrow' definition of unemployment, which is the one always reported in the media, tracks those who are actively seeking employment; for all South Africans it is over 27%. The 'broad' definition includes those who have given up looking; for all South Africans it is over 37%. Disaggregation reveals far more disturbing results: for all 'black' South Africans the figure is 46%, while for the 16–35 age group the figure is 68%.

As importantly is the fact that *work* is the means whereby we recreate ourselves and the world around us. It provides an income and contributes to personal and communal dignity. Not surprisingly, employment creation is a national priority.

However, another component of the dire situation in South Africa is the fact that employment opportunities have to be created for large numbers of people who have little or no education and very few formal skills. The lack of education and skills is largely the disastrous legacy of the 1951 Job Reservation Act and the 1953 'Bantu' Education Act, the combination of which the author has termed *Educocide*.

Economic growth

Economic growth is widely postulated as the solution. In the absence of sufficient economic growth, what does one propose for skills development and employment creation in the face of the actual low levels of education and skill?

Alternative approaches would augment the benefits of economic growth. Certainly, in South Africa *public works programmes* are acknowledged as having a role to play. The 2011 *National Development Plan* recommended that public employment programmes would form a component of the employment strategy until 2030. Labour-intensive industries were to be encouraged. In the construction industry the proper use of *modern labour-intensive methods* would result in a significant increase in the employment generated per unit of expenditure (at least 300%).

Expanded Public Works Programme

The Expanded Public Works Programme (EPWP), initiated in 2004, is a component of the South African government's response to the triple challenge of poverty, unemployment and inequality. It is important at the outset to emphasise that this set of articles only deals with the *Infrastructure Sector* of the EPWP. It is quite important, as this comprises nearly 80% of expenditure on the EPWP – R128.5 billion of the total R163 billion (Figure 1).

The greater use of labour-intensive methods lies at the core of the EPWP.

As mentioned above, conceptualisation of the Infrastructure Sector of the EPWP was partly based on large-scale, long-term programmes of modern labour-intensive construction and maintenance, established elsewhere in sub-Saharan Africa during the 1970s to 1990s. By comparison with conventional construction, these programmes achieved increases in labour-intensity varying from 30% to 65% of site construction cost. During the first ten years of South Africa's independence the Infrastructure Sector of the EPWP failed to achieve the levels of labour-intensity anticipated in its formulation. The extent to which the Infrastructure Sector of the EPWP failed to meet its own targets may be judged by the following: labour-intensity has remained stubbornly around 10%, which is barely more than could be achieved using conventional heavy-equipment, capital-intensive methods.

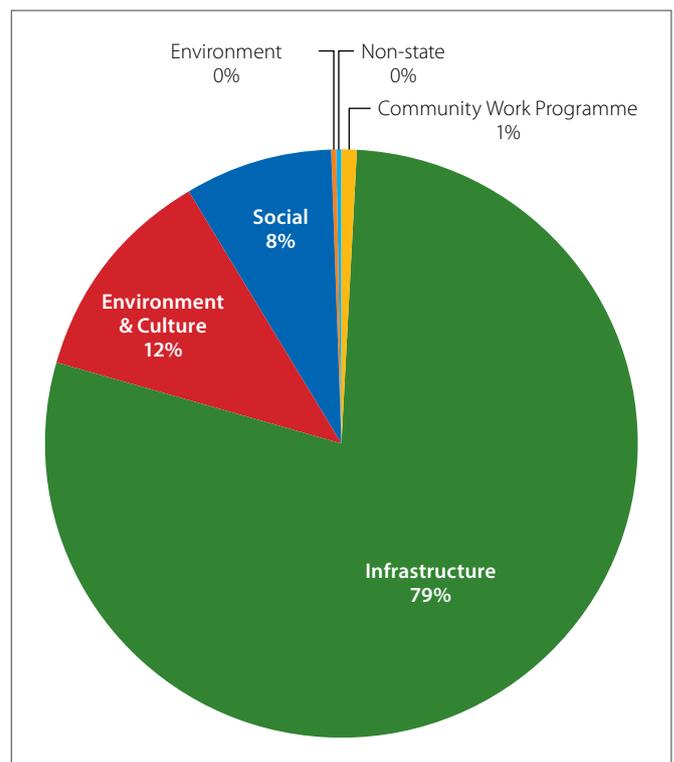


Figure 1 EPWP expenditure by sector – 2004/05 to 2013/14

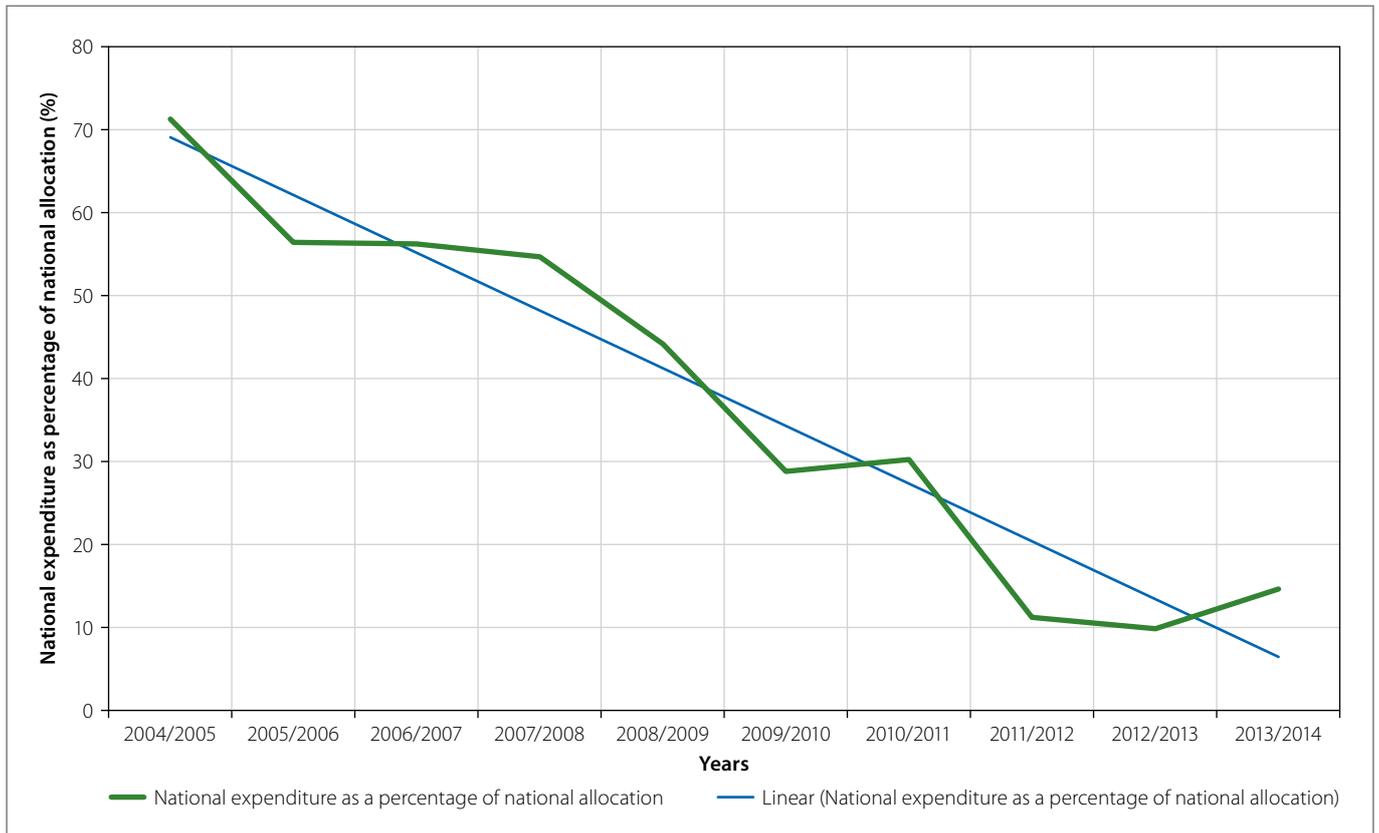


Figure 2 Total national expenditure on EPWP vs allocation – 2004/05 to 2013/14

So, what went wrong, and what are we to do?

In order to be able to assess the reasons for failure it is necessary to provide a framework for analysis. This set of articles will start with a cursory outline of the theory, principles and practice of *modern labour-intensive construction*. It will then sketch the development of the use of modern labour-intensive methods in South Africa. In the first place, it will deal with specific innovatory projects; and then research extensive field-work carried out at, and in association with, the School of Civil and Environmental Engineering at the University of the Witwatersrand. The subsequent section will emphasise the central role of modern labour-intensive methods in relation to public works programmes in South Africa, starting with the Framework Agreement, leading to the National Public Works Programme (1994) and then the EPWP. Having provided this context, these articles will summarise the results of the first two phases of the EPWP, from 2004/05 to 2013/14. This will be followed by an analysis of the reasons for the failure of the EPWP to achieve its stated objectives. It will emphasise the ways in which the South African public works programmes have differed in approach to those used elsewhere in Africa. It will outline the lessons that have been learnt during the South African experience, which will be useful for future implementation in both South Africa and elsewhere in Africa.

While the analysis concentrated upon labour-intensity in the Infrastructure Sector, it also revealed that there is an enormous shortfall between the total allocations recorded in the *EPWP Quarterly Reports* and total expenditure (Figure 2). Given that infrastructure accounted for nearly 80% of allocation and expenditure it is not surprising that the totals are overwhelmed by the data from infrastructure.

The serious inability of the public sector authorities to spend the funds allocated to them has a very negative impact upon

employment and wages. The inability to spend allocated public funds has important implications beyond the question of labour-intensity – the need to improve the ‘in-house’ capacity of the public sector.

These articles will therefore highlight the following: *the consulting engineering profession played an essential and critical role during the articulation of ‘modern labour-intensive construction’*. There are direct implications for engineers who are now expected to achieve both conventional physical objectives and the ‘new normally-expected’ socio-economic objectives.

MODERN LABOUR-INTENSIVE CONSTRUCTION AND MAINTENANCE

The author has provided a background to ‘modern labour-intensive construction’ many times: the definition, theory, principles, potential and examples of large-scale, long-term programmes that linked extensive training to a series of projects.¹

However, it is necessary to *update* and provide a summary of some of the important principles in order to establish a datum for *constructive*² critique of the EPWP.

It is important to start from the definition of ‘modern labour-intensive construction (and maintenance)’:

Modern labour-intensive construction (and maintenance) is the economically efficient employment of as great a proportion of labour as is technically feasible – ideally throughout the construction process, including the production of materials – to produce as high a standard of construction as demanded by the specification and allowed by the funding available. Modern labour-intensive construction results in the generation of a significant increase in employment opportunities per unit of expenditure by comparison with

conventional capital-intensive methods (once systems are established).

This definition is the result of extensive theoretical analysis, practical experimentation and large-scale implementation over a period of at least 40 years.

Modern labour-intensive construction lays the foundation for even more labour-intensive methods of maintenance.

By '*significant*' is meant an increase of at least 300% to 650% in employment generated per unit of expenditure without compromising cost, time and quality. The range varies for different categories of construction.

An illustration is useful here: Conventional rural road construction is highly equipment-intensive; far less than 10% of construction costs go to labour (a large proportion of this labour cost would be for operators and drivers). A 10% to 50% increase in the numbers employed might sound high, but that only amounts to a 11% to 15% *increase* in construction cost going to labour. By contrast, in labour-intensive, rural road construction, 65% of construction cost goes to labour, an increase of 650%.

A corollary to this is what it is *not* – it is *not* the use of large numbers of people on relatively unplanned emergency/relief projects to construct something of ill-defined quality and value. This is often *mislabeled* as labour-intensive. It is actually 'labour-extensive'. From experience and reflection the author has concluded that it is not possible to successfully combine the provision of good infrastructure, constructed using labour-intensive methods with 'make-work' projects. This is not to say that humanitarian endeavours are not required in South Africa. Of course they are. But experience has shown that these cannot be combined with the labour-intensive construction of good-quality infrastructure, particularly high-standard infrastructure, where the vast majority of public expenditure takes place. In the first place, the main focus has to be on high-quality engineering; socio-economic benefits must take second place. If the emphasis is first on poverty relief, or other humanitarian factors, somehow the need for a high-quality product is lost, and things fall apart.

As important: It is essential to generate employment in the major economy, not just trivial social welfare expenditures on the periphery.

Essentially modern labour-intensive construction has two main objectives:

- A technically sound (good-quality), economically efficient product, equivalent to that achieved by conventional construction without jeopardising economic cost, time and quality
- A significant increase in the use of productive labour per unit of expenditure.

How can this be achieved?

Basic concepts and principles related to the technical product and organisational process

General

The success achieved elsewhere in sub-Saharan Africa was founded upon a thorough understanding of the concepts embodied in the above-quoted *definition*. The articulation of these concepts led to the delineation of several sets of principles. These must be followed initially for single-site success and subsequently

for multi-site success over the long term. Some modification might be required to take account of local conditions.

Basic concepts

Between 1971 and 1986 the World Bank (International Bank for Reconstruction and Development) and the International Labour Organisation carried out extensive studies of this topic. Engineers of the calibre of Scott Wilson Kirkpatrick played a major role in addressing the challenge to find ways to generate employment opportunities within the existing economy. They investigated all aspects related to the unusual notion of substituting labour for non-essential equipment.

In 1971 the title of a World Bank component of the research was *Study of the Substitution of Labour³ for Equipment in Road Construction*. By 1973 the title of this particular component of research broadened from *Road Construction* to *Civil Construction*.

Engineers explored the potential of modern labour-intensive construction from several perspectives, in particular *technical feasibility* and *economic efficiency*.

Technical feasibility was of primary importance. There was not much point in advocating the use of labour-intensive methods if the product could not be built labour-intensively (think 'nuclear fission'). Thus, engineers investigated the possibility of using labour-intensive methods for each operation and activity during the construction of infrastructure (*product*).

In 1974, the first major conclusion of this research regarding *technical feasibility* was:

Labour-intensive methods are technically feasible for a wide range of construction activities and can generally produce the same quality of product as equipment-intensive methods.⁴

In particular ... *Earthworks: Excavation, Load, Haul, Unload and Spread (ELHUS)*, which comprise 50% of expenditure on civil construction.

But, note the reference to *wide range*, so it is not exclusive to ELHUS (see section on Research below; also consider the production of building components).

Having addressed and established *technical feasibility*, engineers turned their attention to the question of *economic efficiency*. This required further research and experimentation. Here the focus was not just whether something could be constructed labour-intensively, but how should individual operations and activities be efficiently performed (*process*)?

In relation to the process of construction, considerable research was required regarding the daily organisation of individual sites.

It was essential to know the amount of work an individual or a team could produce. The notion of a set *task* became a core concept at the foundation of modern labour-intensive construction:

- Extensive research and field implementation revealed the output that could be *reasonably* expected of a *reasonable* person in an eight-hour working day. Rigorous time and motion studies were performed based on internationally agreed criteria.⁵ The extent to which these tasks were indeed *reasonable* may be judged by the fact that if workers were told that they could leave the site when they had completed the set task, they generally completed the task in six hours. So, although it is hard work, it cannot reasonably be regarded as *exploitative*

or, more invidiously, as *slave labour*. In official ILO terminology it should reasonably be termed *decent* work.

- Activities within operations were balanced. Efficiency required the 'balancing of the number of people working on an activity that formed part of a larger operation, so that people were not standing or meandering around on site while only a few people were busy.⁶ For example, gravel surfacing consisted of excavation, load, haul, unload and spread activities. Dependent upon the hardness of the material, the ratios would be a variation upon the following: four people would be excavating, two loading and one spreading; in this case a team of seven people.
- Group tasks were also ascertained for various activities and operations.
- On the one hand the supervisor had to know the correct task for a specific operation or activity. On the other, the workers had to have confidence in the supervisor's judgement.

However, in order to base site-operations upon 'tasks' certain 'conditions of employment' were essential: 'outcomes-based remuneration' (ILO terminology). Payment was related to the completion of set individual or group tasks – no work, no pay. Of course there has to be recourse to the law for protection from exploitation and mishap.

The organisation of teams of people required specific skills that could only be achieved through training. This aspect of the process will be dealt with in much greater detail below.

As a result of this extensive research, we reach the second important conclusion, namely on economic efficiency.

Economic efficiency

Wherever the basic wage actually paid ... is less than ... about US\$4 per day in 1982 prices, and labour is available in adequate quantities, the alternative of using labour-intensive techniques should be seriously considered.⁷

In 2003, the ILO considered that \$4 had become \$10.⁸ In 2015 the author carried out a cursory analysis of the South African rand value of US\$10 (in 2003). Based on US inflation rates it was R165.40 and on SA inflation rates R161.60; both were greater than the 2015 daily wage for a labourer of R146. Therefore, based on these admittedly cursory calculations, there is no premium using labour-intensive methods. A great deal of sophisticated analysis would be required to arrive at a more accurate assessment.⁹

Thus during this formative period consulting engineers played a major role in *re-engineering product and process* to establish the rules of the game for 'modern labour-intensive construction'. They developed detailed specifications and procedures for effective site operations. The result was the achievement of high-quality, economically efficient infrastructure *and* specific socio-economic benefits – skills development and employment creation.

From single-site to large-scale multi-site implementation

While it may be seen that single-site success requires considerable innovation, it should not be surprising that this could be achieved with appropriately experienced and innovative engineers. But these come with high overhead costs.

Large-scale operations, on the other hand, were far more complex.

- A public sector institution was made directly responsible for implementation of all works at local, regional and national level.
- Within this institution large-scale, long-term public works/roads programmes were planned and established. A 'programme' means that a related series of projects were planned. Drawing in particular on direct experience and analysis of the programmes in Kenya and Botswana, the prime reason for success was that they adopted a genuine long-term *programme* approach, as opposed to *ad hoc* projects.

Having re-engineered product and process at single site-level and established a framework for a programme, training became a prime focus.

Engineers first developed specific training material and *taught* 'hands-on' single- and multi-site supervisors how to organise and manage both the technical and administrative aspects required for the productive employment of individuals and teams.

Extensive training was required for 'hands-on' single-site supervisors. Additional training was required for the organisation and control of multi-site operations.¹⁰

The training programme paid as much attention to character as technical competence. Upon completion of their training, supervisors worked for much of their time independently¹¹ of senior management.

The construction programme was formally linked to the training programme. And, *maintenance* began *immediately* after

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construction, which led to the need for the training and supervision of maintenance workers.

In summary: *Multi-site operations on a large-scale, over the long term*, required the establishment of a carefully formulated and planned programme, which *formally linked the output of the training to the roll-out of the planned and approved long-term construction programme*.

As a result the programme itself generated the human resources necessary to implement the projects – thousands of ‘hands-on’ single- and multi-site supervisors were trained. The pace of implementation was directly linked to formal training. Expansion on a large scale did not take place at a greater pace than permitted by the production of properly trained personnel. There was a direct link between essential skills development and productive employment creation.

However, it is not only single- and multi-site supervisors who must be trained.

Education and training are required for engineers. Engineers have to be re-orientated given the current mind-set based on the use of heavy equipment, which will be dealt with in greater detail below. If *engineers* do not understand and internalise the concepts, they will not be able to even contemplate taking these concepts and their implications seriously. Thus, *in the first place* they must be *educated* regarding definition, theory, principles and practice. Then they must be trained regarding re-engineering of product and process. They re-engineer the technical components of product and process to enable the use of efficient labour-intensive methods.

Engineers also played a crucial role in the establishment of the requisite integrated planning, coordination and implementation frameworks, including institution building, organisation and training at local, regional and national level.

Which brings us to yet another piece in the training jigsaw puzzle: Major policy and decision-makers at local, provincial and national levels must understand the need for the use of labour-intensive methods, and the complexities associated with single-site and more especially for large-scale implementation. They have to understand the basics, because new ways of doing often lead to contradictory interpretations.

It used to be thought that only *orientation* was required at this level. Unfortunately superficial *orientation* is insufficient to achieve the essential understanding that results from a well thought out and interactive orientation, which amounts to ‘education’. In addition to an understanding of definition, concepts, principles and practice, they must understand that projects and programmes were not considered as *emergency relief* and there was no *fast-tracking*.¹²

Linked programmes of training, construction and maintenance

It cannot be over-emphasised that attention to training is far more important than either the amount of construction or the amount of employment to be created. The physical construction programme must only proceed at the rate to which competent engineers and supervisors have been produced. This is so important that a little more detail is required here.

Figure 3 demonstrates the actual product achieved over thirteen years.¹³ Note the gradual start – a *lead-in time* – during which training, planning and institutional establishment took place; followed by the increase in the rate of production resulting from the extensive basic training.

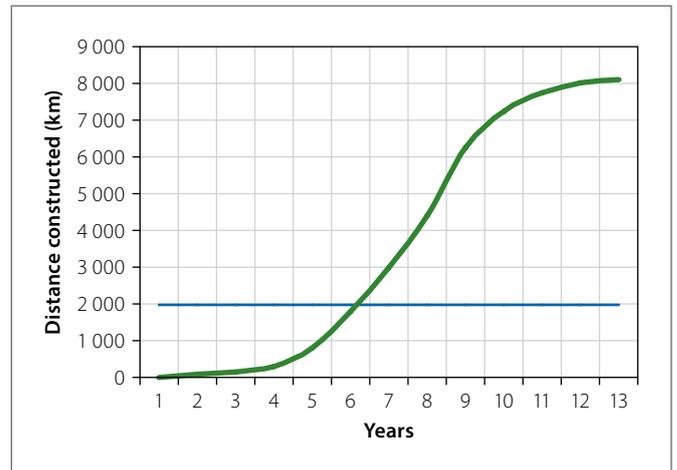


Figure 3 S-curve for development: output vs time
(Actual large-scale, long-term development programme)

Ratio of overheads to site expenditure

Overheads included the following: institution building at local, regional and national level; re-engineering of product and process; orientation and training of engineers; extensive training of ‘hands-on’ single-site and multi-site supervisors; and training of support staff.

- First three years: overheads 84%, site expenditure 16%
- Thirteen years of the programme: overheads 16%, site expenditure 84%.

Note the *gradual* expansion, at the rate to which competent staff had been trained. When linked training and construction programmes are established, training only amounts to 1.5% to 2% of total costs.

The programme approach

During the late 1980s and early 1990s the author investigated the failure of several large-scale South African programmes. He also examined the comparative success of several small-scale projects. In the light of practical experience and reflection upon the much greater success of large-scale rural roadwork elsewhere, the author delineated a strategy and approach whereby the potential could be translated into large-scale reality. These were outlined many times in the early 1990s.¹⁴

In the first place the government would have to adopt a long-term national strategy and a programme approach towards skills development and employment creation. This would need to be located within an institutional framework at national, provincial and local levels.

A sensible programme would need to be developed (not just a collection of *ad hoc* projects). To repeat: a programme is a planned set of projects integrally linked to a formal training programme.

A *lead-in* time would be necessary. During this lead-in period a start would be made on the institutional framework and Phases 1 and 2 below. A four-phased programme approach was succinctly described as follows:

- **Phase One:** Orientation/education¹⁵ of decision-makers as to the principles of labour-intensive methods and their large-scale replication; consensus of all parties concerning type of project, method of construction and conditions of employment.
- **Phase Two:** Preparatory work, i.e. analysis and planning, based on international experience to specify the type of work that would incorporate greater use of local resources,

including single- and multi-site supervisors and unskilled labour; and the potential.

- **Phase Three:** Demonstration project(s)¹⁶ and initial training programme.
- **Phase Four:** Expanded training / large-scale programme: expansion of the pilot/initial training into a large-scale programme. To repeat: expansion should only take place at the rate at which trained people can be produced. Furthermore, successful expansion can only take place at the rate to which the local institutions can productively absorb those trained personnel; equally, whether the national institution is able to absorb and manage its trained management personnel and also maintain its overall role vis-à-vis policy, funding, planning, organisation, training, coordination, monitoring and evaluation.

A *corollary* is that the strategy and these phases must *not be treated as emergency relief*.

In summary

Modern labour-intensive construction has a sound intellectual basis. Principles for single-site construction were derived from extensive research and experimentation. Large-scale, long-term programmes were implemented based on these intellectual foundations and the principles. In turn these led to guidelines regarding the establishment of – and the guidelines for – large-scale, long-term effectiveness.

Elsewhere in sub-Saharan Africa several of the programmes came to an end. This was not because of the ineffectiveness of the use of labour-intensive methods. During the 1990s, for example, Botswana became too rich to qualify for aid funding, and aid to Kenya was reduced. In other countries, such as Malawi, no internal engineering capability was maintained. Once donors moved on to something more fashionable, there was no internal institution to continue the work. Furthermore, since much of this work was carried out from the 1970s to the 1990s, little institutional memory remained. Thus, from a broader African perspective, there would be mutual benefits to be gained by countries in Africa from greater knowledge about the multi-faceted experience throughout the continent.

Speaking generally, any skilled artisan generates work opportunities around him/her for unskilled people who, besides gaining an income, will also be closer to opportunities to improve their skills. Artisanal development must therefore be at the core of national policy. The use of labour-intensive methods provides even greater opportunities for skills development and employment creation. In relation to modern labour-intensive construction the 'hands-on site supervisor' is the equivalent of the artisan.

Engineers played a major role in the formulation and implementation of these programmes – they *re-engineered product and process* in order to achieve high-quality, economically efficient infrastructure *and* specific socio-economic benefits, namely skills development and employment creation.

From the above it may be seen that expenditure of public funds on high-standard public infrastructure may be done in such a way as to also develop skills and create employment. But these secondary benefits at the local level will not be achieved through the 'parachute' method or mere 'tinkering'. They can only be achieved through a *long-term programme approach* that links the whole process, including the following: conception, design

and specification, training at all levels, site organisation, management and institutional development.

In South Africa consulting engineers should play a greater role in re-engineering the provision of high-standard public infrastructure so as to also generate skills and employment.¹⁷ Although there will be a humanitarian component to this engagement, *engineering* considerations *must* be paramount. If the social-welfare component is too dominant, very little of physical value will be built.

Above we have provided elements of the intellectual background against which to constructively evaluate the EPWP. For another component of the intellectual framework, we now turn to developments in South Africa prior to the initiation of the EPWP.

SOUTH AFRICAN PROGRESS IN RELATION TO MODERN LABOUR-INTENSIVE CONSTRUCTION PRIOR TO THE EPWP: INNOVATION AND RESEARCH

A summary of labour-intensive policy and practice in South Africa

There are four prime sources for the origin of South African policy on labour-intensive construction. The one is the need for a large public works programme outlined in the ANC's Reconstruction and Development Programme (1994).¹⁸ The second is the fact that the use of proper labour-intensive methods during construction can generate skills and a significant increase in employment per unit of construction. The third and fourth are the innovative projects and research mentioned above and sketched below.

Since 1991 the author has contributed to the conceptualisation, formulation and implementation of public employment creation programmes in South Africa. This started with the Framework Agreement between COSATU and the SA construction industry. In 1994 the Framework Agreement formed a major component of the new democratic government's National Public Works Programme (NPWP). In 2004 the NPWP morphed into the Expanded Public Works Programme (EPWP).

But the author's experience was not *remotely* the only source of the conceptualisation of the Framework Agreement, the National Public Works Programme or the Expanded Public Works Programme.

Innovative projects, NQF4 level qualifications and training material

During the 1980s and 1990s innovative projects were carried out using modern labour-intensive methods. Of particular note is the work carried out under the auspices of the Valley Trust in KwaZulu-Natal (Mann and Little), at Ilinge in the Eastern Cape (Croswell), and at Mohlaletse in Greater Sekhukhune (Donaldson Trust, Universities of the Witwatersrand and Twente (The Netherlands)).

Ilinge, Eastern Cape

In the mid to late 1980s, at Ilinge in the Eastern Cape, James Croswell engineered, designed and supervised (correct word) the construction of a range of housing and its municipal services using highly labour-intensive methods. These included: buildings, roads, stormwater drainage, water supply and reticulation, small-bore sanitation and 54 000 m³ maturation ponds (primary, secondary, tertiary).¹⁹ One of his criteria for design and specification was that all items had to be constructed 'by hand'. Where it was deemed that the rock was *unpickable* ('blue sparks') then

a compressor was brought onto site. The example of the 'drum' for the small-bore sanitation system is particularly stimulating. Instead of importing concrete or plastic tubs from a long distance away, concentric concrete rings were made on site, which could be manhandled by four people, slid into the hole and sealed with mastic. James Croswell acted as a managing consultant: implementation was carried out by selected small contractors, who were also trained by Croswell.

By comparison with the programmes in Kenya and Botswana, there was a major difference between the essential mode of operation at Ilinge. James Croswell's project in the Eastern Cape was implemented using small contractors. Instead of operating through the medium of *instruction*, the contractor – and therefore the *contract* – became extremely important.

Croswell's first dictum is that the project must be designed from the very start to be built labour-intensively: all items must be 'built by hand'.

- This is achieved by designing the project from the start to be built by hand.
- In formal project management language an objective such as this is referred to as the 'design driver'.
- Having designed the project to be built by hand and re-engineered the project completely, the contract documentation must follow suit. The implications of the decision to make greater use of productive labour must be rigorously incorporated into the contractual documentation. This includes *modification of each section of whichever form of contract is used*: the project specifications, the bills of quantities, and the tender and evaluation process.
- Subsequent construction has to be in accordance with the contract.

Thokoza Road, KwaZulu-Natal

During 1983 Robert Little visited the labour-intensive construction programme in Botswana. At that time he was a consultant to the Valley Trust, an NGO located in the Valley of a Thousand Hills. The Trust was run by Chris Mann. Although logistically close to the economic powerhouse of Durban, the Valley was beset by high levels of unemployment and poverty. On returning from Botswana, Little persuaded the Trust to use highly labour-intensive methods to construct a 13 km stretch of road. He subsequently engineered and supervised the construction of Thokoza Road in the Valley of a Thousand Hills (particularly mountainous terrain).

Soweto secondary water mains

Croswell considers that this early 1990s project was even more important for demonstrating the effectiveness of the use of modern labour-intensive methods in South Africa. Delivery was via small contractors.

Several factors contributed to this assessment, including the fact that it was the first major urban LIC project and the fact that it took place in Soweto. Although a specific programme of training had not been available, attempts were made to identify people with construction skills and, equally important, 'people management skills', to consider as contractors. In addition, and as a result of the extraordinary commitment of the engineer, several of the problematic areas in small contractor development were circumvented. These included direct payment via the engineer to obviate delay in payment from the client, and a full team of

experienced mentors who were available on a constant basis throughout the contract. It is perhaps unrealistic to expect this level of commitment to be replicated on a national scale, but it does indicate that, given the correct approach, labour-intensive contract can be successful. Factually more than 200 km of secondary water mains were installed with an absolute minimum of 'machine intervention' and the cost was verified by external audit to be 30% less than through a conventional contract. A contributing factor to this saving was that there was far less damage to existing services than had been contemplated, and that there was a high level of community 'buy-in', which contributed to the relatively smooth running of the contracts.

Accredited qualification and training material

Successful construction operations require a range of construction operatives and skilled site supervisors. This applies to both equipment- and labour-intensive construction. Thoroughly trained *hands-on site supervisors* are absolutely crucial for modern labour-intensive work.

During the early 2000s an accredited NQF4 level qualification for this category of person was developed for CETA. The training material was based on unit standards. The author was one of the team members responsible for generating appropriate standards in the construction industry.

The qualification required that the unit standard on 'Labour Intensive Construction Systems and Techniques' had to be obtained by all candidates plus a choice between 'Water and Sanitation', 'Roads and Drainage' and 'Construction, Repair and Maintenance of Structures'. A candidate specialised in one of the three categories; additional study and experience enabled a candidate to be competent in two or three categories. The qualification was titled *Construction Processes Site Supervisor*. The courses were structured so that the unit standards chosen meant that the same title of the qualification was valid for either equipment- or labour-intensive construction – considerable time and effort are required to produce a person who can organise and productively control the technical activities of groups of people.

The specifics have been formally defined in terms of class learning and mentored experience. In summary, about 18 months' training is required to achieve the NQF4 qualification.

Although the format of the training may be allowed to vary, the author is convinced that it is essential for the class instruction to be closely related – in time – to the field experience.

At the time of the formulation of the NQF4 qualification²⁰ an NQF2 level qualification was established for a contractor (it has since been raised to NQF level 4). In itself this initial setting of the level at 2, displayed an ignorance of various aspects of running a contract, in particular the technical essentials.

All unit standards and training material were made available on open source and were accessible on the internet.

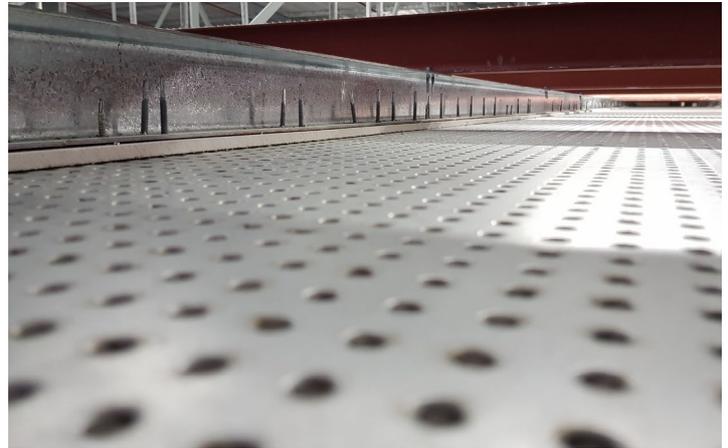
Although we have seen the crucial importance of the 'hands-on' site supervisor for effective modern labour-intensive construction, very little systematic training of construction processes site supervisors has actually taken place. However, the next project is a prime example of where such training did take place.

Mohlaletse, Limpopo

Starting in 1996, funded by a grant from the Donaldson Trust, a development programme was established at Mohlaletse

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in Greater Sekhukhune.²¹ It was organised by the WORK Research Centre in the School of Civil and Environmental Engineering, University of the Witwatersrand, and students from the University of Twente (The Netherlands). Between 2002 and 2005 the Umsobomvu Youth Fund funded two successful NQF4 level courses for a *Construction Processes Site Supervisor*. Trainees had to have a matric. The rigorous selection process was followed by one month's refined selection, which led to a cohort of 60 trainees. The 18-month course consisted of two nine-month components. The 60 trainees were separated into two groups of thirty. During the first nine months, classroom instruction alternated with site training – one week in class, the next on site. Thus, there were always 30 trainees in class and 30 on site. Construction proceeded slowly and steadily, without hiatus. During the second nine-month component, additional site training and intensive mentoring experience were carried out. The 18-month total is not ideal, but considerably better than nothing, or the bogus two-day or two-week training on 'life skills'. Each course trained about 60 people to become NQF4 level construction processes site supervisors. Several of the more enterprising trainees proceeded to further training as independent contractors. While these courses preceded the actual SAQA-accreditation process, the training material was the basis for future SAQA accreditation.

Although chronologically inconsistent, it is worthwhile mentioning the following:

In a *Mid-term Review of Free State EPWP* (2007) one analyst (not known to the current author) carried out a review of the Free States EPWP. It was actually stated that the training in Sekhukhune should be the model for the national EPWP.²²

Extensive Research and demonstration proved validity for high-standard infrastructure

As mentioned above, elsewhere in Africa large-scale, long-term implementation took place in relation to the construction and maintenance of rural roads. The author's initial emphasis focused solely on the substitution of labour for (non-essential) equipment in a rural environment in South Africa.

However, starting in 1989, research and field implementation at, and in association with, the University of the Witwatersrand (Wits) was carried out on four other avenues of increasing the generation of employment per unit of expenditure.²³ The four avenues of investigation may be categorised as follows:

- Substitution of labour for non-essential equipment.
- Labour-intensive materials (and their related techniques and technologies) that have been used in the past but have been replaced (and thus obscured from professional view) by the use of materials that are more amenable to the use of capital-intensive methods. For example, water-bound macadam is a high-quality base course which was used throughout South Africa until the mid-60s. The size of the stone is such that it cannot be placed into a correct camber using a grader. It has to be placed by hand, which includes the removal of over-sized material. Considerable research and field experimentation were carried out into the use of rubble masonry concrete for culverts. More recently, work has been carried out into dam construction.

- Modification of existing materials in such a way as to enable the use of labour-intensive methods and lowering the need for imported equipment. For example, a bitumen with a modified chemistry.
- New materials that would increase the proportion of labour and decrease that of imported equipment. For example, ion exchange stabilisers such as sulphonated petroleum products were recognised as having labour-intensive construction potential.

In all four approaches it is essential to understand that, in order to generate significantly more employment per unit of expenditure, it is imperative that this objective is incorporated into the design and contract documentation, including conditions of contract, specifications and bills of quantity. As mentioned, the labour-intensive technology thus becomes the 'design driver', requiring that the designers think through the processes long before site implementation. Labour-intensive methods cannot be effectively 'tacked on' during the construction phase alone. In all four approaches to labour-intensive construction, research and prototype development have been necessary.²⁴

Of particular note is the research and physical implementation carried out in relation to water-bound macadam and slurry-bound macadam. In Soweto, Gertzen demonstrated that high-standard urban roads could be built using highly labour-intensive methods: "27% went directly to labour and, if some of the management support site staff are included, then 37–43% was retained in the broader Soweto community."²⁵ In association with Wits and EIEC, Van Steenderen was responsible for the construction of the water-bound macadam base course of 13 km of the Great North Road (the N1 between Matoks and Machado). Hattingh's work with water-bound macadam in Soweto led to experimentation with slurry-bound macadam. He proceeded to develop a patented spinning beam for level control. He also developed a set of equipment costing about R200 000 which was suitable for use by small contractors; it could compete with a mobile asphalt plant costing R2 000 000.

This research and field implementation in South Africa demonstrated that the potential and scope encompass far more than low-cost, low-volume roads. Research and practical implementation have re-confirmed the findings of the World Bank's study. It is, indeed, technically feasible across a wide range of civil construction, and can result in the same quality of product. Under properly conceived, designed and well-managed circumstances, it can be economically efficient and even cost competitive with conventional construction. High-standard, major civil construction projects can be built using labour-intensive methods, and contractors could play a greater role in implementation.

REFERENCES

The list of references for the full set of articles is available from the author.

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The author wishes to thank the following people for their dedicated collaboration and vigorous intellectual challenges over the past 25 years: James A Crosswell, Filip Taylor Parkins, Wim van Steenderen, Harry Quainoo and Johan Hattingh. This article is dedicated to the memory of Profs Stephen Emery and John Howe, both of whom made significant contributions to this field of endeavour. □

NOTES

- 1 Several of these were written before wide-spread digitisation, which is another reason for a fresh summary. However, this year two papers were presented at the FIDIC-GAMA Conference organised by CESA; and two articles published in the August and October issues of *IMIESA*.
- 2 There is no point in simply being critical; one has to be able to provide improvements.
- 3 American spelling was used throughout their work, i.e. 'labor'. For this article the author has used UK English, i.e. 'labour'.
- 4 World Bank / International Bank for Reconstruction and Development 1974. *The Study of the Substitution of Labour and Equipment in Civil Construction Phase III – Final Report*, Staff Working Paper Number 172.
- 5 ILO *Manual on Work Studies*.
- 6 This should not be surprising. In conventional construction mass haulage operations balance dozers, loaders and trucks.
- 7 World Bank / International Bank for Reconstruction and Development 1986. *The Study of the Substitution of Labour and Equipment in Civil Construction: A Research and Implementation Project Completion Report*. Washington: IBRD, Operations Policy Staff, Transportation, April.
- 8 Majeres, J 2003. Employment Intensive Investment and Poverty Reduction: The Wider Policy Framework. *ILO ASIST Bulletin*, No 15, March: 1–3.
- 9 In fact it would require a thorough re-evaluation of the 1971 to 1986 research carried out by the Bank and the ILO.
- 10 Here is an important link to the type of training which would be applicable to potential small contractors.
- 11 Often in isolated environments.
- 12 "Low-hanging fruit" is another term to be avoided.
- 13 The Kenyan Rural Access Roads Programme.
- 14 McCutcheon various; summarised McCutcheon 2001b.
- 15 'Orientation/education': stated as such in an original 1990s paper.
- 16 Often mislabelled 'pilot'. We are way beyond the need for exploratory pilots. Unfortunately 'demonstrations' will probably still be necessary.
- 17 It is also suspected that Africa could re-learn lessons from its own successes.
- 18 ANC Reconstruction and Development Programme 1994.
- 19 Ilinge 27 000 m³: 80 × 300 (primary secondary tertiary) split in half 54 000 (2014 Diary).
- 20 In the early 2000s.
- 21 McCutcheon *et al* 2005. Key people involved: Paramount Chief Sekhukhune and other Members of his Council, Benji Donaldson, Peter Delius, Malose Kekana, James Crosswell, Filip Taylor Parkins, Wim van Steenderen, Hubert van Zandvoort and Arjen Bouwmeister. A number of other students from the Netherlands made valuable contributions.
- 22 Free State Department of Public Works, Roads and Transport. An Impact Study of the Implementation of Expanded Public Works Programme in the Free State. *Mid-Term Review Final Draft*, 5 May 2008, p 38.
- 23 The results of some important research and experimentation was summarised in *Employment and High Standard Infrastructure* (McCutcheon and Taylor Parkins (eds) 2003). A complete set of references to all the research carried out at the University of the Witwatersrand has been compiled. It is available on request.
- 24 Relevant authors and chapters from *Employment and High Standard Infrastructure* (2003) to be added here, if necessary. They are listed in the References: Bangma, Crosswell, Emery, Gertzen, Grobler, Hattingh, Horak, Lieuw Kie Song, Moloisane, Quainoo, Rankine, Phillips, Taylor Parkins, Van Steenderen, Van Wijk.
- 25 Gertzen 1997.